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Abstract: The midfoot is made up of five bones with numerous articulations. Midfoot fractures are often associated with high-energy trauma and may have a significant impact on function and quality of life. This case of a 17-year-old exemplifies the complexity of midfoot fractures and the importance of restoring proper anatomic alignment to decrease morbidity and improve long-term functionality in patients.

Key words: Midfoot injury, Lisfranc injury, Chopart’s joint, pediatric injury, percutaneous fixation

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Midfoot fractures are well studied in the adult population but are relatively uncommon in adolescents [1]. Midfoot fractures and dislocations are most commonly the result of high-energy trauma but may occur secondary to low energy injuries. In a review of the literature, midfoot injuries occur in roughly 10% of polytrauma [4]. A thorough clinical exam is of critical importance in any patient where midfoot injuries are suspected. These types of injuries may present with a wide variability, ranging from localized pain, that is exaggerated with weight bearing, to severe edema and hematoma formation over the midfoot. In subtle injuries, pain to palpation may be the only positive finding. In more severe injuries, plantar ecchymosis may be a pathognomonic sign of midfoot injuries, suggesting rupture of the strong plantar ligaments [3]. Midfoot injuries are often
missed and underdiagnosed thus, resulting in significant morbidity and functional decline. High energy type injuries, such as a high fall, can cause gross deformities and severe crush injuries. Neurovascular exam is a key component in ruling out compartment syndrome. If significant dislocations or fractures are present, urgent reduction and splinting should be performed to minimize the risk of soft tissue necrosis and neurovascular compromise. Depending on the stability of the injury or fracture pattern, the use of temporary external fixation may be necessary. Radiographic assessment is essential and should include both foot and ankle views. Conventional radiography can be misleading, especially in subtle injuries. Computed tomography (CT) is an important tool in understanding the extent of an injury and may be critical for pre-operative planning. Fixation may vary depending on many factors such as the patient’s age, fracture or dislocation pattern, severity of injury, and quality of the soft tissue envelope. Goals of fixation should be aimed at achieving proper reduction of all fracture/dislocations and restoring the integrity of the longitudinal and transverse arches of the foot. We present a case of a 17 year old male who sustained a high-energy complex midfoot injury involving dislocation and fractures of the midfoot after a 15-foot fall from a rooftop.

Methods
A search of the literature was conducted regarding pediatric midfoot crush injuries, and treatment options until April 2018. References from the appropriate articles were also reviewed to find all reports and outcomes of pediatric injuries in the literature.

Case Report
A 17-year-old male presented to clinic complaining of a painful right foot. The patient worked as a local roofer and stated that he fell from a height of 15 feet while working and landed on his right foot. On initial presentation, the patient described four out of ten aching pain across the right foot. He denied pain to the contralateral foot or leg, neck, lower back, hips or knees. The patient had no significant past medical history, was not on any medications and had no known drug allergies. A year earlier, the patient underwent open reduction internal fixation (ORIF) of his left fourth metatarsal following a fracture due to a similar type of injury, that ended up healing uneventfully.

On physical exam, pedal pulses were palpable with brisk capillary refill to all digits. A neurological exam was negative for any paresthesia’s. Dermatologic exam was significant for diffuse non-pitting edema and ecchymosis to the plantar, medial, and lateral right foot. There were no fracture blisters noted. On musculoskeletal exam there was a significant amount of midfoot instability noted with manual manipulation. Pain was elicited with palpation across the right midfoot. Range of motion and muscle strength was deferred secondary to pain.

Right foot plain film radiographs were taken in clinic and revealed multiple midfoot fractures including comminution of the cuboid and plantar subluxation of the navicular. A CT scan revealed multiple
additional fractures to the intermediate and lateral cuneiforms and to metatarsal bases one, three and four.

Figure 1a & 1b. Lateral and oblique views of the right foot demonstrated partial dislocation of the cuneiform-navicular joint along with comminution of the cuboid.

Figure 2. CT coronal views displaying fractures of the cuboid, intermediate and lateral cuneiforms and metatarsal bases 1, 3, and 4.

Due to the patient’s persistent swelling and concerns of further soft tissue injury, the decision was made pre-operatively to percutaneously reduce and stabilize the midfoot using k-wire fixation. This allowed for stabilization and reduction of the fractures and dislocations while minimizing trauma to the soft tissue envelope.

The patient underwent spinal anesthesia with a popliteal block to the right lower extremity. Closed reduction under fluoroscopy was attempted to relocate the navicular-cuneiform joint. After the dorsal cortices of the talus, navicular, and medial cuneiform were re-aligned, the medial column was then stabilized with two 0.62 k-wires. Next, the second tarsometatarsal joint and calcaneo-cuboid joint were reduced and stabilized with a 0.62 k-wires as well. For extra stabilization and reduction, k-wires were then placed across the fourth tarsometatarsal joint and intercuneiform joints. One last k-wire was placed through the base of the first metatarsal and into the base of the second metatarsal. A total of eight 0.62 k-wires were used to reduce and stabilize the patient’s midfoot. Exiting K-wires were covered with antibiotic ointment and non-adherent dressings.
Finally, a dry sterile compressing dressing was applied with a posterior splint. Follow up radiographs were taken on post-op days (POD) 15, 43, and 71. Radiographic assessment of alignment and boney consolidation were adequate at each visit. All K-wires were removed on POD 43. Afterwards, the patient was instructed to begin partial weight bearing in a CAM boot. Following the fourth and final office follow up, on POD 71, the patient was full weight bearing and pain free.

**Figure 3a & 3b.** Intraoperative fluoroscopy displaying the use of percutaneous k-wires to obtain anatomical reduction of all fractures/dislocations.

**Figure 4a & 4b.** Weight bearing radiographs 10 weeks post op with boney consolidation and appropriate anatomic alignment.

**Discussion**

There has been little published data regarding Lisfranc and midfoot injuries in children and adolescents. It has been reported that foot and ankle fractures only represent 12% of all pediatric fractures, with malleolar fractures being the most dominant injury [13]. Current estimates within the adult population suggest that the incidence of Lisfranc injuries is approximately 1 in 55,000 emergency room visits. Estimates suggest 1 in every 5 Lisfranc injuries are missed on initial exam. Koster et al. reported that 41% of all midfoot fractures are missed completely [4,10]. Midfoot injuries that go undiagnosed may result in significant morbidity. Current literature suggests that Chopart’s joint injuries are even less common compared to tarsometatarsal joint injuries, although both are just as likely following high-energy trauma [5]. Whether a Lisfranc, Chopart’s, or both, it is important to evaluate and treat for possible soft tissue or neurovascular injury, compartment syndrome, and fractures else where in the foot and body. Regardless of fixation techniques, most authors are in agreement that proper anatomical reduction needs to be the focus of treatment. Anatomical alignment is defined as the medial border of the middle cuneiform being in line with the second metatarsal base on anterior-posterior radiographs, the lateral border of the lateral cuneiform being in line with the third metatarsal base on oblique radiographs, and the medial border of the cuboid being in line with the base of the fourth metatarsal base on oblique radiographs as well [14].

Veijola et al. retrospectively examined seven teenagers who had experienced a Lisfranc injury. Injuries ranged from purely ligamentous, to osseous fracture or dislocations. All seven patients underwent ORIF with the use of screws and K-wires. In this study all but one patient returned to pre-injury activity level and had good anatomic reduction of their injuries [6]. It is worth noting that not all pediatric midfoot injuries involve a fracture of bone. Hill et al. also examined...
results from fifty-six children following Lisfranc injuries through their own retrospective analysis. Their results showed that 39 injuries were reported as fractures, while the remaining 17 were just ligamentous sprains and about 61% of these injuries were sustained while playing some sport [9]. The authors went on to report that 100% of Lisfranc sprains received no form of intervention and went on to heal uneventfully [9]. The author also mentioned that out of the 39 reported Lisfranc fractures, about 19 patients, or 34% of patients underwent operative treatment, and noted that patients with closed physes were more likely to undergo surgical correction [9].

There is limited published literature regarding pediatric midfoot injuries, and even fewer reports documenting the use of percutaneous fixation. Wagner et al. examined twenty-two patients who underwent percutaneous screw fixation following a Lisfranc injury. In this study they evaluated time until full weight bearing. Results showed 100% anatomical reduction of injuries, and full-unrestricted weight bearing at 12.4 weeks [7]. Doshi et al. published a similar case report, where surgical intervention was performed using percutaneous k-wire fixation. Authors reported a 24-year-old male who sustained a fall from a significant height resulting in a dorsal dislocation of the intermediate cuneiform. The patient underwent closed reduction in the operating room, followed by percutaneous k-wire fixation to further maintain and support proper anatomic alignment [8]. The patient was kept non-weight bearing for 6 weeks and k-wires were subsequently removed at that time.

Looking at the data published for Lisfranc and midfoot injuries within the adult population provides better comparison of fixation techniques against one another. Schepers et al. examined the anatomical reduction of Lisfranc injuries for patients who underwent closed reduction versus open reduction with internal fixation. Reported results favored ORIF, with 86% (19/22) of ORIF patients achieving acceptable reduction, compared to only 33% (2/6) of patients undergoing closed reduction classified as acceptable reduction [11]. When comparing different forms of ORIF, Hu et al. prospectively examined sixty patients undergoing two forms of ORIF to repair Lisfranc fractures, with thirty-two patients undergoing solely screw fixation versus those who underwent screw and plate fixation. Overall, patients receiving a dorsal plate crossing the TMTJ complex reported better AOFAS scores, and reported less post operative pain. Authors suggested the plate enhanced the “rigid stability” across the Lisfranc complex [14]. This notion of increased “rigid stability” for these midfoot injuries can be seen as reproduction of Coetzee’s 2007 historical article comparing ORIF and primary arthrodesis. Coetzee’s results indicated that patients who underwent arthrodesis of the Lisfranc joint following a Lisfranc injury not only reported better AOFAS scores, but had a higher percentage (92% vs 65%) to return to pre-injury activity [12].

In conclusion, more research and investigation may be warranted regarding incidence and treatment for high-energy midfoot injuries sustained within the pediatric and adolescent populations. Although there is much literature within treatment options for the adult population, there is little consensus on proper fixation for children who experience some form of a midfoot injury. Further research may help provide additional information in order to effectively manage these patients, thus affording more positive surgical outcomes within this specific patient demographic.

References


